Evaluación de Riesgos Naturales
- América Latina -
Consultores en Riesgos y Desastres

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CAPRA

CENTRAL AMERICA PROBABILISTIC RISK ASSESSMENT

EVALUACIÓN PROBABILISTA DE RIESGOS EN CENTRO AMÉRICA

BELIZE

TASK IV

HAZARD, RISK MAPS AND RISK MANAGEMENT APPLICATIONS

<u>TECHNICAL REPORT SUBTASK 4.2E</u>

BELIZE CITY HURRICANE RISK INSURANCE

CEPREDENAC

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This application is illustrative, and has limitations and restrictions due to the level of resolution of available information. The final user should be aware of this, so that he will be able to make appropriate and consistent use of the results obtained, taking account of the type of analysis made, the type and quality of data used, the level of resolution and precision, and the interpretation made. Therefore, the following should be noted:

- Models used in the analysis contain simplifications and suppositions in order to facilitate the calculation which the user of which the user should be aware. They are described in detail in the related technical reports.
- The analyses have been developed with the best information available, within limitations of reliability and currency. It is possible that better and more complete information exists, but that we did not have access to it.
- The information used and the results of the analysis of hazards, exposure and risk are associated with a level of resolution, depending on the unit of analysis used, and this is explained in the descriptive document of the example.
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1 Introduction

In general terms, the cities in developing countries, in particular in Latin America and the Caribbean, are exposed to high risks associated with natural phenomena, in particular, earthquakes and hurricanes. For the case of occurrence of a phenomenon with disastrous characteristics, it is foreseeable that there will be a high level of economic loss associated with different groups of infrastructure and exposed infrastructure, such as private residential property, commercial property, industry and so on, the buildings of health and education sector both private and public, government buildings, infrastructure in public services and buildings for them, and in some cases other private and public buildings, through mechanisms of concession, and finally, the general infrastructure of government in municipalities, departments or counties and the country as a whole, such as roads, bridges, the electricity generation and distribution systems, water and gas supplies, hydrocarbons, ports, airports, and other complementary systems.

In order to minimize the financial impact which the event may generate with its catastrophic characteristics, there must first be a definition and implementation of a long-term financial strategy, to reduce known fiscal vulnerability of governments, and the level of the city or region, or indeed the whole country. The strategy includes a definition of a structure for retention and transfer of risk.

The retention of risk is usually covered by reserve funds, budget allocations or contingent loans which will allow financial resources required for emergency attention to be available at the instant of the occurrence of the catastrophic event, and for financing to be available to the retained part of the risk in the medium and long term.

This transfer is conducted generally by a scheme of insurance and reinsurance, and for this purpose the entire insurance sector must be involved, since the intention is to design a strategy for events with catastrophic characteristics. The cost of transferring the risk for the insured is the value of the premium, which in general should be proportional to the value of the annual expected loss of the asset insured. However, in practice, nominal values of premiums are used, attempting to average out values, such that with this figure there can be a cross subsidy of risk premiums between the wealthier strata, and those whose income does not allow for this type of expense, and which by that very circumstance, their risk would be transferred to the government entity in charge.

These considerations lead to the need to make studies which will give us a proper understanding of the financial risk to which each of the components of the city's – or region's or country's – infrastructure is exposed, and to develop the technical knowledge required to design a transfer structure with operative tools and instruments which will encourage users, and at the same time allow the central government to cover at least part of the contingent liability which is implicit in association with a possible disaster in the city.

The tools for systematization and modeling of catastrophic risk which leads to an estimation of the levels of damage and loss will also enable proposals to be made for a number of alternatives in the structure of retention and transfer, which will be feasible in accordance with the optimum conditions of cost for users, the realities of the insurance and reinsurance markets, and possible mechanisms for financial protection to be explored. These options would need to be proposed considering the legal restrictions in force, and possible changes that would favor an optimum process of insurance and adequate cover.

The final objective of this type of application consists on the design and proposal for mechanisms which are in accordance with the law and local regulations. This can be applied and negotiated with insurance companies so that there would be an optimum contract which will determine what amount each of the users retains, what excess of what limit of excess can be taken up by the insurance and reinsurance sectors, what the level of pure premiums would be; and how a series of cross subsidies could be proposed in order to finance the premiums of the poorest strata; and how a business could be structured from the point of view of an insurance or reinsurance business to be technically, operatively and financially viable. The value of the premiums depends on the size of the layers or excess loss limits, the value of deductibles specified, and other possible sources of protection such as contingent credit – if that is viable in terms of cost – or even capital market securities. The analysis of which mechanisms and why and for what value depends on legislation (both obligations of the public sector and of the insurance sector), and of the capacity of companies, cost of insurance, and what is considered to be appropriate and optimum from a financial point of view.

The assessment presented here considers the best available information with regard to buildings and their characteristics which form the database for the city. However, since the information supplied was not complete, estimates had to be made for a series of parameters for each of the assets exposed, using indirect indicators and information. The results should therefore be considered as indicative, considering that the information on the database could be significantly improved, and that since it is based on analysis and approximate correlations, in particular in relation to characteristics proper to each construction.

The results of the analysis presented here are based on the results of the analysis of risk for hurricane presented in the report ERN-CAPRA-T4-2a (Evaluation of the risk of disaster in Belize City, ERN 2010).

For the purposes of this report, we use the following definitions:

- Probable Maximum Loss
- Average Annual Loss

The PML is an estimate of the maximum loss which can be expected in a group of buildings. For this, a low annual probability of exceedance is selected, as being considered acceptable, and account is taken of the useful life of buildings, to calculate the losses for this value of probability. This defines the time period for the generating event (for example, 1500 years). In the analysis, all possible scenarios for hurricane are generated for that return period (that is, with the same probability of occurrence), and the expected loss in buildings is calculated for each scenario.

The average annual loss is defined as the average expected loss that would be generated annually with a group of buildings and for each building. In order to determine this, the level of hazard to which the portfolio of buildings is exposed must be known, and the vulnerability of their structures.

2 Portfolio of buildings and parameters

2.1 Characterization of the analysis database

The database forming the portfolio for this analysis is composed of buildings. For each of these, basic reference information is based on correlations and typical characteristic values. All the information obtained is presented in detail in the report ERN-CAPRA-T4-2a. Table 2-1 presents a list of parameters required for the analysis.

Table 2-1
Information on the database

General Information	Construction Classification
Socio-economical level Use or activity Occupation Exposed value Physical average annual loss	Area Number of stories Structural system

Figure 2-1 presents the distribution of exposed value by use, and the approximate number of buildings associated with them.

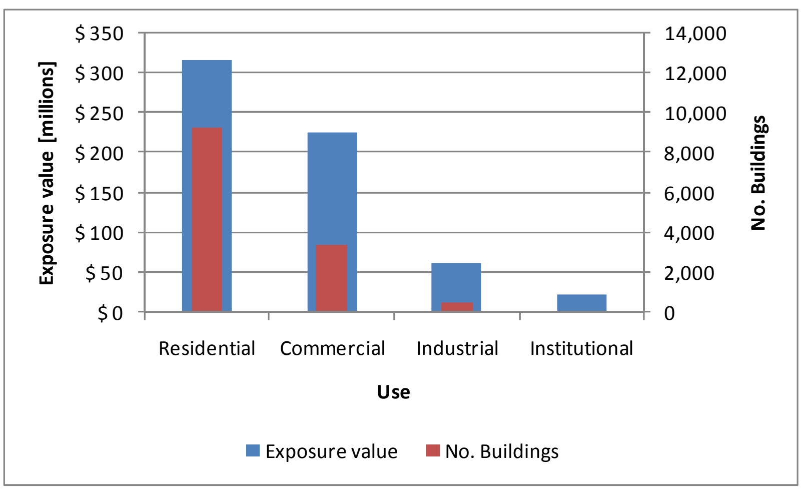

Figure 2-1
Exposed values and number of buildings distribution by use

Table 2-2 summarizes the general characterization of the database used in the analysis.

Table 2-2
Summary of the principal characteristics of the building's database

Use	Socio-economical category	No Buildings	Exposure value [US$ mill.]	Occupation [Hab]	Average annual loss Wind & storm surge [US$ mill.]	[‰]
Commercial	High	215	$ 45.7	3,059	$ 1.2	26.7
	Medium	2,977	$ 173.3	11,594	$ 5.7	32.9
	Low	200	$ 5.1	340	$ 0.2	30.5
Industrial	High	22	$ 7.1	336	$ 0.2	35.0
	Medium	409	$ 50.6	2,403	$ 1.4	28.6
	Low	20	$ 3.6	171	$ 0.1	35.6
Institutional	High	8	$ 8.6	1,301	$ 0.3	32.9
	Medium	27	$ 14.6	2,203	$ 0.6	42.7
Residential	High	1,005	$ 102.3	4,863	$ 3.3	32.6
	Medium	6,405	$ 196.0	19,689	$ 6.4	32.6
	Low	1,851	$ 18.0	11,538	$ 0.6	32.3
Total		**13,139**	**$ 624.9**	**57,498**	**$ 20.1**	**32.2**

In conclusion, the database is formed by around 13,000 buildings, with an insurable value of US$ 625 million, with an occupation of around 57,500 people, and an average annual loss due to hurricane hazard of US$ $20 million, which is equal to 3.2% of the total exposed value.

2.2 Characterization of insurable values and expected losses

Figure 2-2 and Figure 2-3 present exposed values and average annual losses by type of use and socio-economic category.

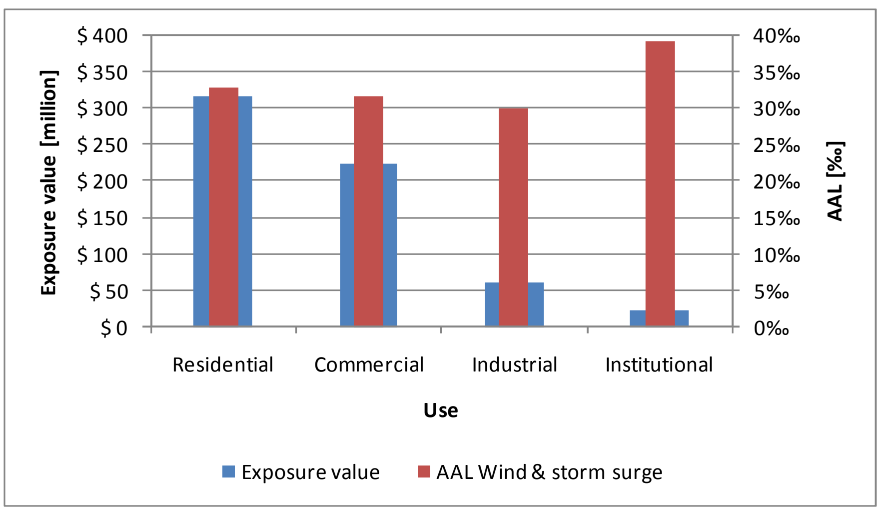

Figure 2-2
Exposed value and average annual loss distribution by use

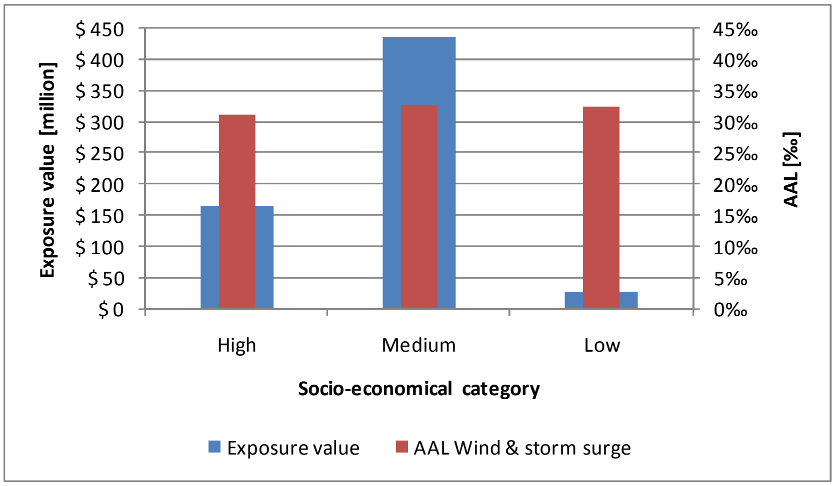

Figure 2-3
Exposed value and average annual loss distribution by socio-economical category

2.3 Analysis groups for the insurance scheme

Using the characterization of the database presented in the previous section, a segmentation of the target group for analysis was made for a compensation plan with cross premiums or cross insurance, which in this case has been taken as the group of residential buildings.

Table 2-3, Figure 2-4 and Figure 2-5 summarize the principal values for the three groups of selected for the analysis to establish compensation in premiums or cross insurance.

Table 2-3
Summary of values for the analysis groups

Socio-economical category	No Buildings	Exposed value		Average annual loss Wind and storm surge		
		[US$ mill.]	[%]	[US$ mill.]	[‰]	[US$ x Bldg]
High	1,005	$ 102.3	32%	$ 3.3	32.6‰	$ 3,320
Medium	6,405	$ 196.0	62%	$ 6.4	32.6‰	$ 999
Low	1,851	$ 18.0	6%	$ 0.6	32.3‰	$ 314
Total	**9,261**	**$ 316.3**	**100%**	**$ 10.3**	**32.6‰**	**$ 1,114**

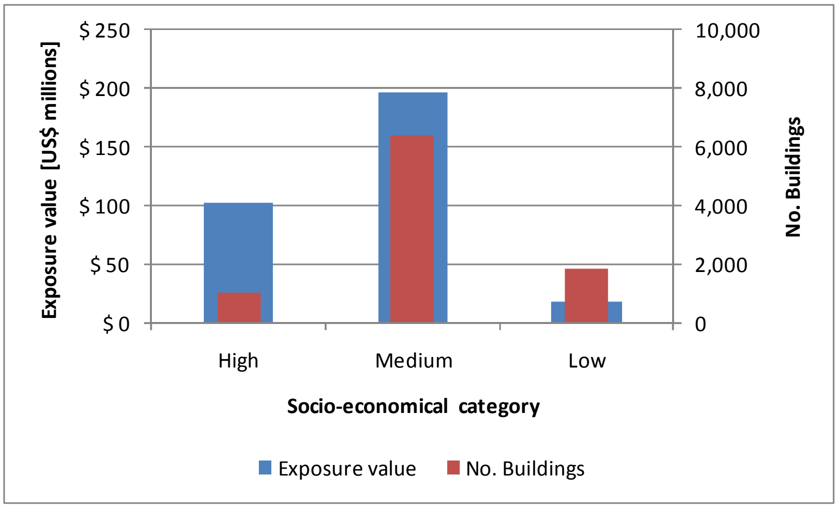

Figure 2-4
Exposed value and number of buildings distribution by socio-economical category for the group of residential buildings

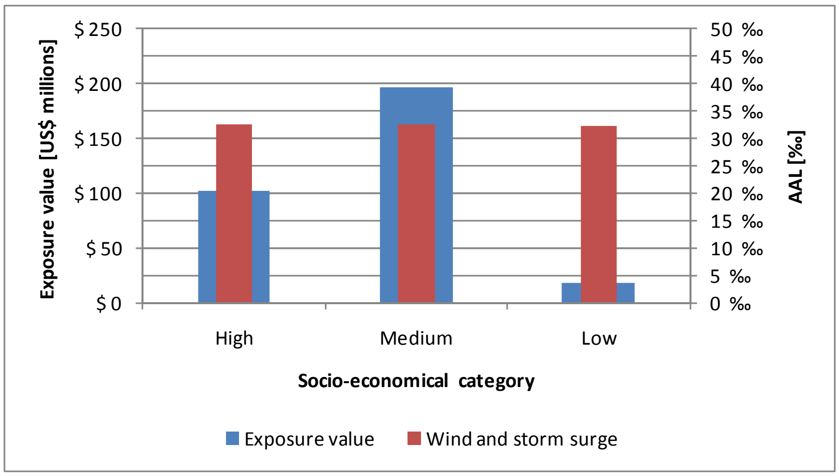

Figure 2-5
Exposed value and average annual loss distribution by socio-economical category for the group of residential buildings

In Figure 2-4 we observe the differences in average annual losses for the three groups analyzed, and the largest losses regarding to the insured value are those for the group of buildings of the low socio-economic strata, with a value close to 3%.

3 Results of risk by sectors

In this section, the results of the risk analysis for hurricane are presented for the entire portfolio analyzed, and individually for each of the groups selected for analysis. The results of the analysis presented in terms of exposed value, average annual loss in monetary terms, and in relation to the exposed value, and probable maximum loss for different return periods.

All the analysis presented were calculated using the CAPRA-GIS (ERN 2009) system. This analysis allows technical criteria and possible scenarios to be generated for the design of better insurance alternatives.

3.1 Complete portfolio

The results of the analysis for the entire portfolio are presented in Table 3-1, and in Figures 3-1 to 3-3.

Table 3-1
Average annual loss and probable maximum loss

Risk results		
Exposed value	US$ mill.	316.33
Average annual loss	US$ mill.	10.31
	‰	32.61‰
PML		
Return period	**Loss**	
year	**US$ mill.**	**%**
50	77.00	24.34%
100	92.43	29.22%
250	113.60	35.91%
500	125.96	39.82%

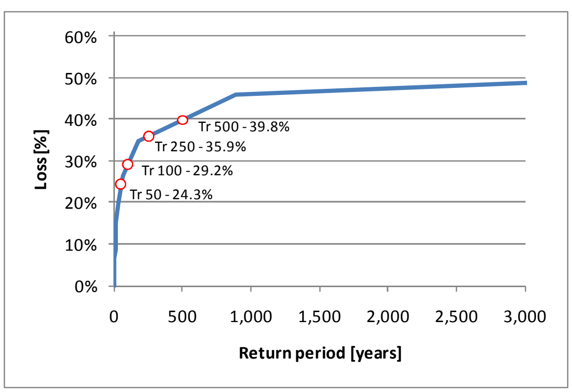

Figure 3-1
Variation of PML with the return period

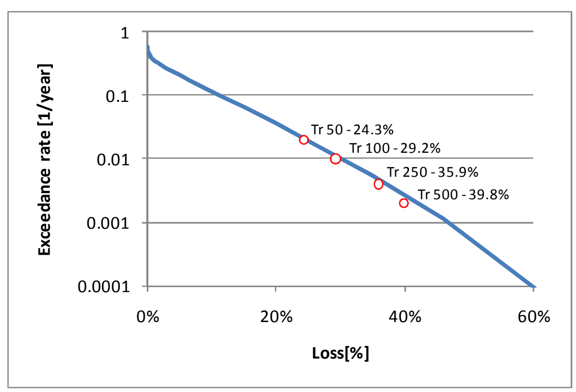

Figure 3-2
Loss exceedance rate curve

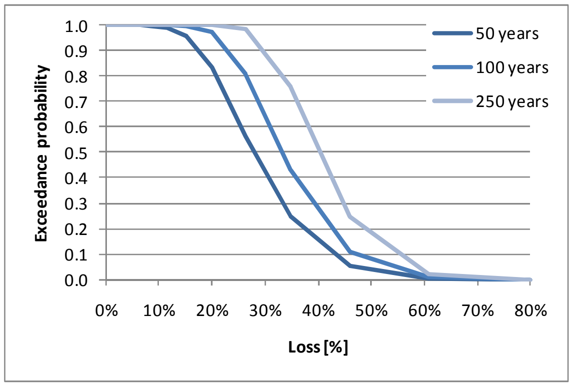

Figure 3-3
Loss exceedance probability for different exposition timeframes

3.2 Lower socio-economical category

The results of the analysis for the group of buildings in low socio-economical category are presented in Table 3-2, and in Figures 3-4 to 3-6.

Table 3-2
Average annual loss and probable maximum loss for buildings in low socio-economical category

Risk results		
Exposed value	US$ mill.	17.99
Average annual loss	US$ mill.	0.58
	‰	32.25‰
PML		
Return period	**Loss**	
year	**US$ mill.**	**%**
50	4.38	24.35%
100	5.27	29.30%
250	6.48	36.04%
500	7.23	40.19%

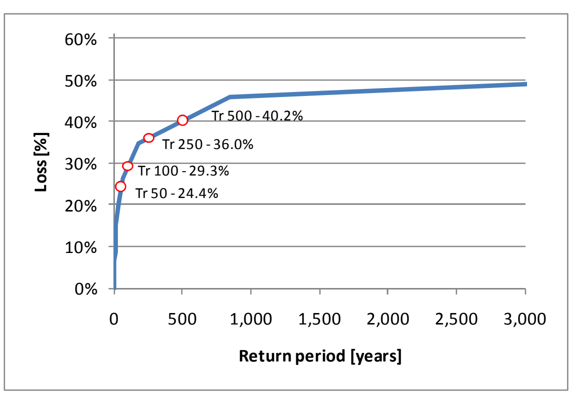

Figure 3-4
Variation of PML with the return period

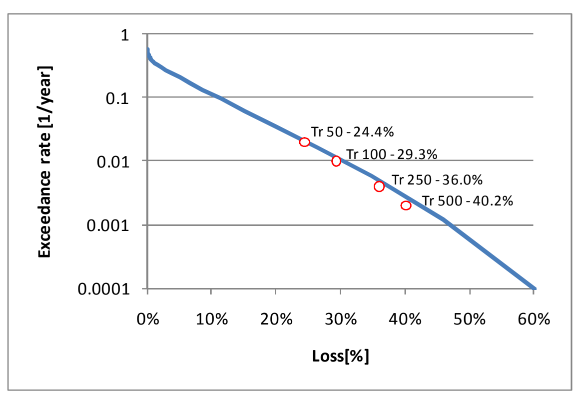

Figure 3-5
Loss exceedance rate curve

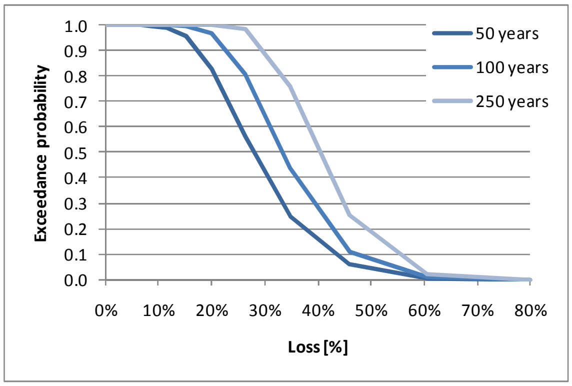

Figure 3-6
Loss exceedance probability for different exposition timeframes

The group of approximated buildings of low socio-economic level represents 20% of the total, and 6% of total exposed value. The premium is low, US$0.6 million or 3.2% of their exposed value.

3.3 Medium socio-economical category

The results of the analysis for the group of buildings in medium socio-economical category are presented in Table 3-3, and in Figures 3-7 to 3-9.

Table 3-3
Average annual loss and probable maximum loss for buildings in medium socio-economical category

Risk results		
Exposed value	US$ mill.	196.03
Average annual loss	US$ mill.	6.40
	‰	32.64‰
PML		
Return period	**Loss**	
year	**US$ mill.**	**%**
50	47.95	24.46%
100	57.49	29.33%
250	70.58	36.01%
500	78.51	40.05%

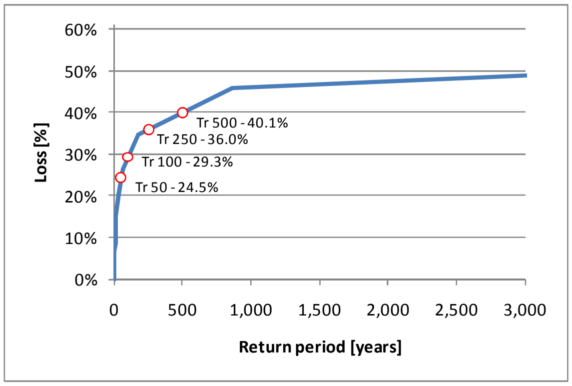

Figure 3-7
Variation of PML with the return period

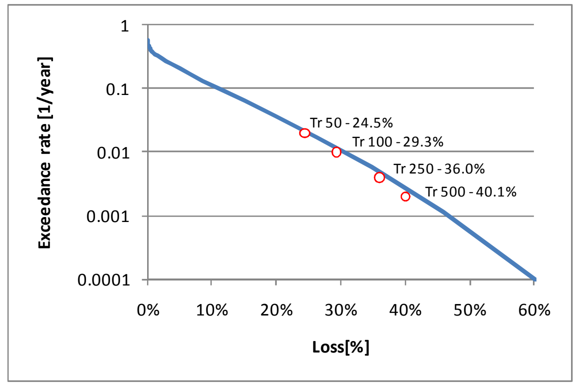

Figure 3-8
Loss exceedance rate curve

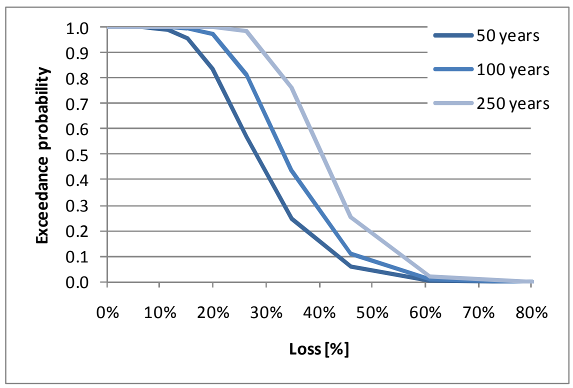

Figure 3-9
Loss exceedance probability for different exposition timeframes

The group of approximated buildings of medium socio-economic level represents a 69% of the total, and 62% of total exposed value. The premium for hurricane hazard corresponds to some US$6.4 million or 3.3% of their exposed value.

3.4 High socio-economical category

The results of the analysis for the group of buildings in high socio-economical category are presented in Table 3-4, and in Figures 3-10 to 3-12.

Table 3-4
Average annual loss and probable maximum loss for buildings in high socio-economical category

Risk results		
Exposed value	US$ mill.	102.31
Average annual loss	US$ mill.	3.34
	‰	32.61‰
PML		
Return period	**Loss**	
year	**US$ mill.**	**%**
50	25.03	24.47%
100	30.04	29.36%
250	36.86	36.03%
500	41.00	40.08%

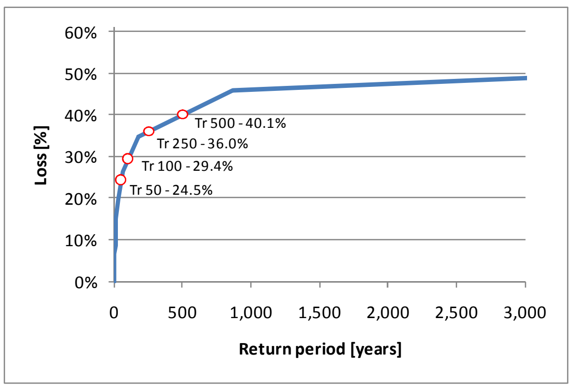

Figure 3-10
Variation of PML with the return period

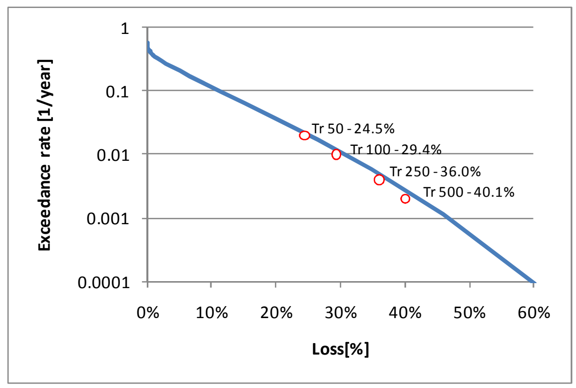

Figure 3-11
Loss exceedance rate curve

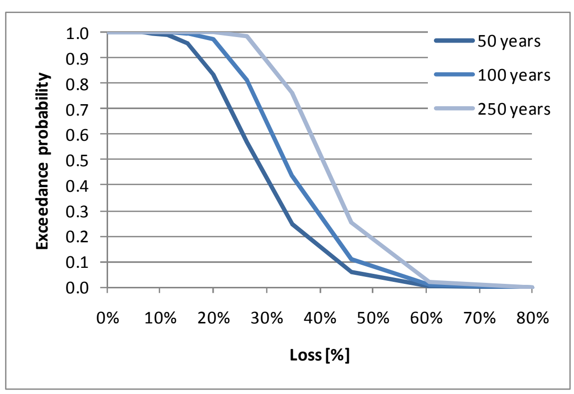

Figure 3-12
Loss exceedance probability for different exposition timeframes

The group of approximated buildings of the highest socioeconomic strata represents 11% of the total number and 32% of insured value. The premium for hurricane hazard is about US$3.3 million (3.3 % of the exposed value).

4 Estimation of premiums considering compensation

The analysis of separate portfolios, conducted and mentioned above, allows to make estimates of the value of premiums (average annual loss), for the average of each of them, and to explore the possibility that one group or fraction of that group, such as those of the highest socio-economic strata, should cover the cost of insurance of the buildings owned by the less wealthy, for example, the low socio-economical strata. This means that there will be a compensation of premiums between high and low socio-economic levels.

In the determination of buildings which qualify for subsidy, priority must be given to low social economic strata. Regarding to that, consideration must also be given to the fact that the value of the premium for this group of buildings is about US$ 0.6 million, while the buildings which make contributions towards that a compensation or subsidy, is around US$ 9.7 million.

For this example of the analysis of cross-insurance, the scenario taken is one in which the contributors are all of the middle and high-strata owners, and would be practically a scheme of mandatory insurance for these socioeconomic strata.

4.1 Insurance with premium compensation

4.1.1 *Compensation by socio-economical category*

For the scenario proposed for insurance with compensation, in which those subsidized correspond to about 1,850 buildings of a low socio-economical category, the shortfall would be US$ 0.6 million to cover US$ 18 million of exposure.

And if the rest remaining of the buildings are to make contributions, there are some 7,400 in the middle and higher socioeconomic strata, and the total amount of premiums to be paid by those contributors would be US$10.3 million with which the premium for the medium level socio-economical groups would be an increase from 3.26% to 3.52%, and for the high-level income socio-economical group, from 3.26% to 3.34%.

Table 4-1
Loss compensation or crossed insurance results

Socio-economical category	No Buildings	Exposure value		Average annual loss Wind and storm surge			Cross average loss Wind and storm surge		
		[US$ mill.]	[%]	[US$ mill.]	[‰]	[US$ x Bldg]	[US$]	[‰]	[US$ x Bldg]
Low	1,851	$ 18.0	6%	$ 0.6	32.3‰	$ 314	$ 0.0	0.0‰	$ 0
Medium	6,405	$ 196.0	62%	$ 6.4	32.6‰	$ 999	$ 6.9	35.2‰	$ 1,077
High	1,005	$ 102.3	32%	$ 3.3	32.6‰	$ 3,320	$ 3.4	33.4‰	$ 3,398
Total	**9,261**	**$ 316.33**	**100%**	**$ 10.3**	**32.6‰**	**$ 1,114**	**$ 10.31**	**32.6‰**	**$ 1,114**

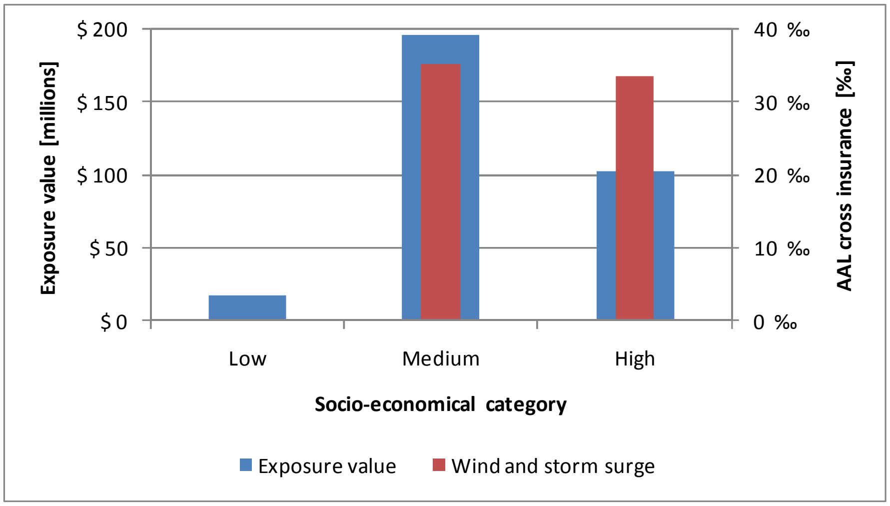

Figure 4-1
Exposed value and average annual loss distribution by group after cross insurance scheme

4.1.2 *Compensation by limiting the exposed value*

It is possible to propose an insurance scheme with the compensation factor, from the point of view of exposed value, in which the subsidized group would be composed of buildings with an exposure value of less than a given limit. In this example, this value limit has been placed at US$17,500, which corresponds to most of the buildings in the low socio-economic strata buildings.

Table 4-2
Annual losses compared to the limit exposed value (subsidized)

No. of buildings		Exposed value		Average Annual Loss Wind and storm surge	
[Und]	[%]	[US$ million]	[% total]	[US$ million]	[% total]
3,268	35.3%	$ 32.00	10.1%	$ 1.05	10.2%
			AAL [‰]	$ 32.83	
			US$ x Bldg	$ 321.53	

Table 4-3
Annual losses compared to the limit exposed value (contributors)

No. of buildings		Exposed value		Average Annual Loss Wind and storm surge	
[Und]	[%]	[US$ million]	[% total]	[US$ million]	[% total]
5,993	64.7%	$ 284.33	89.9%	$ 9.26	89.8%
			AAL [‰]	32.58‰	
			Cross average loss [US$ million]	$ 10.31	
			Cross AAL [‰]	36.28‰	

5 Conclusions

The analysis offers the following preliminary conclusions, which may serve as the basis for proposing strategy for future considerations of optimum mechanisms of retention and transfer of risks:

(a) The complete portfolio of buildings, according to inferred information, consists of some 13,000 buildings, with an insurable value of about US$ 625 million, and an annual expected loss in the case of hurricane winds and storm surge of US$ 20 million, equal to 3.2% of the exposed value.

(b) A first scheme of global insurance would indicate that the pure premium for hurricane risk for the entire portfolio would be of the order of 33 per thousand, corresponding to some US$10 million, the probable maximum loss for 500 years of the return period estimated for this portfolio is around US$126 million, corresponding to 40% of the exposed value, and in this case, would need catastrophic reinsurance, if the local insurance companies do not wish to retain significant percentages of the risk.

(c) For a scheme such as that indicated, and considering the difficulties of proposing a scheme of mandatory insurance, it may be expected that there will be a low participation on the part of low socio-economic strata owners. In similar experiences and cases, overall values of participation have been of the order of 10%. Therefore, the scheme, although feasible for implementation in the medium term, does not guarantee the protection of low socioeconomic strata housing, and therefore the city should still consider this contingent loss to be valid, in the case of the catastrophic event.

(d) An alternative scheme of insurance consists of producing a compensation of premiums between the wealthier and the poorer strata. In order to compensate all the premiums of 35% of the buildings with the lowest exposed values, corresponding to buildings with an exposed value of less than US$17,500, the average premium for the remaining buildings will increase on average from 32.5 to 34.6 per thousand. This value may vary drastically, if different levels of participation are considered.

(e) The foregoing analysis allows concluding that the possibility of a scheme of insurance will depend on the reinsurance capacity of local insurance companies, and it will be necessary to enter into direct negotiations with the reinsurance companies, and to analyze the viability of the proposal. The possibility of establishing compensations for premiums of the lower-value buildings is clear, given the low values of pure premiums resulting in general for this group of buildings. If we consider that the schemes are voluntary, it might be proposed that a scheme of coverage for a higher limit in the lower-value houses could be established as a function of the percentage of properties which enter the scheme of insurance proposed.

(f) Also, and as a new general program for insurance, it will be necessary to propose a series of incentives for individuals to decide to support the program, including reduced tax payments, special exceptions, extra time to pay, amnesties, works of intervention for retrofittment of housing, and other measures which generate clear incentives to taxpayers.

6 References

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